terraces and Cenozoic uplift. U. S. Geol. Survey Prof. Paper 400-B, pp. B 202-B 207.

Bishop, Ernest W. 1956. Geology and ground water resources of Highlands County, Florida. Florida State Geol. Surv., Rept. Invest., no. 15, pp. 1-115.

Brodkorb, Pierce. 1955. The avifauna of the Bone Valley formation. Florida State Geol. Surv., Rept. Invest., no. 14, pp. 1-57.

———. 1963. Miocene birds from the Hawthorne Formation. Quart. Jour. Florida Acad. Sci., vol. 26, pp. 159-167.

Carr, W. J., and D. C. Alverson. 1959. Stratigraphy of middle Tertiary rocks in part of west-central Florida. U. S. Geol. Surv., Bull. 1092, pp. 1-111.

Cathcart, J. B. 1950. Notes on the land-pebble phosphate deposits of Florida, *in* Symposium on mineral resources of the southeastern United States. University of Tennessee Press, pp. 132-151.

———. 1963a. Economic geology of the Keysville Quadrangle Florida. U. S. Geol. Surv. Bull. 1128, pp. 1-82.

———. 1963b. Economic geology of the Chicora Quadrangle Florida. U. S. Geol. Surv. Bull. 1162-A, pp. A 1- A 66.

———. 1963c. Economic geology of the Plant City Quadrangle Florida. U. S. Geol. Surv. Bull. 1142-D, pp. D 1- D 56.

Cooke, C. Wythe. 1945. Geology of Florida. Florida State Geol. Surv., Geol. Bull., no. 29, pp. 1-339.

Espenshade, G. H., and C. W. Spencer. 1963. Geology of phosphate deposits of northern peninsular Florida. U. S. Geol. Surv., Bull. 1118, pp. 1-115.

Hunter, Frank R. 1949. Occurrence of heavy minerals in the pebble phosphate deposits of Florida. A.I.M.E. Trans., vol. 181, pp. 413-416.

Isphording, W. C. 1963. A study of the heavy minerals from the Hawthorn Formation and overlying Pleistocene sands exposed at the Devil's Mill Hopper, Alachua County, Florida. University of Florida, unpublished thesis, pp. 1-31.

Ketner, K. B., and L. J. McGreevy. 1959. Stratigraphy of the area between Hernando and Hardee counties, Florida. U. S. Geol. Surv. Bull. 1074-C, pp. 49-124.

Klein, Howard, M. C. Schroeder, and W. F. Lichtler. 1964. Geology and ground-water resources of Glades and Hendry counties, Florida. Florida State Geol. Surv., Rept. Invest., no. 37, pp. 1-101.

Martens, James H. C. 1935. Beach sands between Charleston, South Carolina, and Miami, Florida. Geol. Soc. America Bull., vol. 46, pp. 1563-1596.

McClellan, Guerry H. 1962. Identification of clay minerals from the Hawthorn Formation, Devil's Mill Hopper, Alachua County, Florida. University of Florida, unpublished thesis, pp. 1-38.

Pirkle, E. C. 1956. The Hawthorne and Alachua formations of Alachua County, Florida. Quart. Jour. Florida Acad. Sci., vol. 19, pp. 197-240.

———. 1958. Lithologic features of Miocene sediments exposed in the Devil's Mill Hopper, Florida. Quart. Jour. Florida Acad. Sci., vol. 21, pp. 149-161.

Pirkle, E. C., and W. H. Yoho. 1961. Folding and warping resulting from solution with associated joints and organic zones in clayey sands at Edgar, Florida. Quart. Jour. Florida Acad. Sci., vol. 24, pp. 247-266.

Pirkle, E. C., W. H. Yoho, A. T. Allen, and A. C. Edgar. 1963. Citronelle sediments of peninsular Florida. Quart. Jour. Florida Acad. Sci., vol. 26, pp. 105-149.

Pirkle, E. C., W. H. Yoho, and A. T. Allen. 1964. Origin of the silica sand deposits of the Lake Wales Ridge area of Florida. Econ. Geol., vol. 59, pp. 1107-1139.

Puri, Harbans S., and Robert O. Vernon. 1959. Summary of the geology of Florida and a guidebook to the classic exposures. Florida State Geol. Surv., Special Pub. 5, pp. 1-255.

Reves, William D. 1960. An X-ray study of two Florida land pebble phosphate samples, in 9th Field Trip Guide Book of Southeastern Geological Society, Tallahassee, pp. 50-63.

Sellards, E. H. 1909. Mineral industries. Florida State Geol. Surv., Second Ann. Rept., pp. 235-291.

———. 1910. A preliminary paper on the Florida phosphate deposits. Florida State Geol. Surv., Third Ann. Rept., pp. 17-41.

Simpson, G. G. 1929. The extinct land mammals of Florida. Florida State Geol. Surv., Twentieth Ann. Rept., pp. 229-279.

Thoenen, John R., and John D. Warne. 1949. Titanium minerals in central and northeastern Florida. U. S. Bur. Mines Rept. Inv. 4515, pp. 1-62.

Vernon, Robert O. 1951. Geology of Citrus and Levy counties, Florida. Florida State Geol. Survey Bull., 33, pp. 1-256.

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A NEW CIRRIPED FROM THE EOCENE OF GEORGIA

Arnold Ross

Late in 1964 Dr. Katherine Van Winkle Palmer, of the Paleontological Research Institution, forwarded to the author a large number of disarticulated, and a few articulated, balanomorph barnacles from the Eocene of Georgia. Eocene Balanidae from the Atlantic and Gulf Coastal Plains are virtually unknown.

In the appendix to his "Synopsis of the organic remains of the Cretaceous group" Samuel Morton (1834) cited *Balanus ostrearum* as a member of the southeastern United States fauna. Both Darwin (1854b), and Kolosváry (1955, 1961) attributed this species to Conrad as did Morton. Conrad may have found the specimen, assigned a name to it, and allowed Morton to publish it; Conrad never published the name. Because this species was neither described nor figured the author must therefore consider it to be a *nomen nudum.*

Morton (1834, p. 72), earlier in the same paper, reported a species "Found by Mr. Conrad in the calcareous strata of South Carolina," which he named *Balanus peregrinus.* Darwin (1854b, p. 492), in referring to *B. peregrinus,* stated, " . . . this Eocene species apparently resembles the *B. unguiformis* of Sowerby . . . " This appears unlikely since *B. peregrinus* is a well-ribbed form that reaches a " . . . diameter from half an inch to one inch and a half" (Morton, 1834, p. 72). Although this species was originally described and figured by Morton, and subsequently by Conrad (1846a), its true nature cannot be determined at this time because the diagnostic characters cited are presently of no taxonomic value. *Balanus peregrinus* is here considered as a *species inquierenda.*

Balanus humilis was described by Conrad (1846b) from a limestone outcropping in the Tampa Bay region ("Hillsborough Falls") of Florida. This species was believed to be of early Eocene age, although at present the Tampa Limestone, from which this species presumably was collected, is assigned an early Miocene age.

In the obscure half-page paper by Holmes (1859) two balanids were reported from the "Eocene Marl of Ashley River," *Balanus digitatus* and *Balanus calceolus. Balanus calceolus* Ellis is a European conopean that ranges from Helvetian to Recent. The short, one-paragraph descriptions of the species unfortunately do not lend themselves to modern studies. Holmes' failure to obtain

opercular valves further obscures the true nature of both forms. His illustrations add nothing to terse, but unimportant morphological details. Furthermore, the stratigraphic occurrence of these species must be redetermined in the light of subsequent refinements in the stratigraphy of South Carolina. Therefore, it appears best to consider these two forms as *species inquirendae.*

Otto Meyer (1886, 1887) reported "*Balanus antiquus,*" originally described as a new species of *Crucibulum* (Gastropoda), from the Claiborne Formation, middle Eocene, of Alabama. Although Pilsbry (1930) contended that it was "not recognizably defined," he did note that the opercular valves of the sole specimen were present. Zullo (letter dated November 29, 1964) found that several specimens in the University of California Museum of Paleontology from the Claiborne and Jackson groups in Alabama may be referable to "*antiquus.*"

Withers (1953) reported the presence of *Balanus* sp. aff. *B. unguiformis* Sowerby from sediments of the upper Eocene Jackson group of Mississippi. The stratigraphic range of this species is Auversian (Zullo, 1960b) through Rupelian (Withers, 1953), although Davadie (1963) recorded it from sediments as late as Helvetian. Zullo (1960a) reported the occurrence of a species conspecific with, or related to, *B. unguiformis* from the Claiborne and Jackson groups of Alabama. He has also (1960b) noted the occurrence of an undescribed hesperibalanid on the Pacific Coast of the United States.

Several Eocene Balanidae have been described from European sediments. The hesperibalanids *Balanus unguiformis* and *B. erisma,* described by James De Carle Sowerby in 1846, were probably the first Eocene species reported from Europe. Darwin (1854a) considered *B. erisma* to be a variety (= subspecies) of *B. unguiformis,* and further considered (Darwin, 1854b) *B. perplexus* Nyst, 1853, from the Eocene of Belgium, to be conspecific with *B. unguiformis.* Kolosváry (1947) reported two species from Hungary, *B. hantkeni* from the middle Eocene, and *B. phineus* from the late Eocene (1958). Both species were, unfortunately, described solely on the basis of shell morphology. Recently, Kolosváry (1961) described another balanid, *B. vialovi,* from the late Eocene of the U.S.S.R. In addition, members of the *B. concavus* and *B. tintinnabulum* complexes have been reported from Eocene sediments (Davadie, 1963), but these records must be substantiated.

Balanus sublaevis was briefly described and figured by Sowerby in a geological memoir by Grant (1840) and has not since been redescribed. Recently, Kolosváry (1961) cited this Asian species as an Eocene faunal element, even though it was originally reported from "Tertiary" sediments. It is the writer's belief that Kolosváry's assignment is unjustifiable.

Institutional abbreviations used in the present study are as follows: Paleontological Research Institution, P.R.I.; Florida State Museum, F.S.M.

Type Locality

The sediments from which the barnacles were collected outcrop approximately 22 miles southeast of Augusta on the Savannah River, at Shell Bluff Landing, Burke County, Georgia (P.R.I. field station 1894). Maps of this area may be found in Herrick's studies on the Shell Bluff Foraminifera (1960, 1964).

A generalized lithologic section at this locality was presented by Cooke (1943). The barnacles were collected from Cooke's unit 6, which is referred to the Barnwell Formation of Eocene (Jacksonian) age. Herrick (1964) confirmed Cooke's age determination, and correlated this horizon with " . . . the type Moodys Branch Formation of Mississippi."

The specimens herein described were collected by the late G. D. Harris, J. Hauck, and Katherine V. W. Palmer in October, 1946.

Order THORACICA Darwin, 1854

Family **Balanidae** Gray, 1825

Subfamily Balaninae (Gray), 1825

Genus *Kathpalmeria*, new genus

Definition. Sessile barnacles having six compartments with solid walls and solid, wholly calcareous, basis. The rostrum, laterals, and carinolaterals lack (?) or possess diminutive radii, the sutural edges of which are dentate. The wall plates are moderately folded, the reentrants forming buttresses on the inner shell surface. Internally, the buttresses and intervening spaces are strong to slightly ribbed. The scutum is sulcate externally, and bears a strongly developed articular ridge, but no adductor ridge.

Etymology. This new genus is named in honor of Dr. Katherine Van Winkle Palmer in recognition of her outstanding contributions to the Eocene paleontology of the southeastern United States.

Type species. Kathpalmeria georgiana, new species.

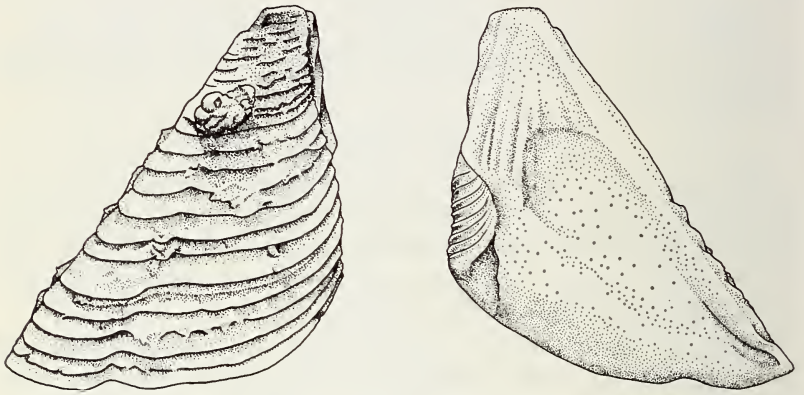

Fig. 1. *Kathpalmeria georgiana,* new genus, new species. Drawings of external and internal views of holotype scutum, P.R.I. no. 6075b. Actual height 4.3 mm. Drawings prepared by Miss Brenda Baer.

Remarks. This new genus is proposed to include, in addition to the new species described below, *Balanus hantkeni* Kolosváry (1947) from the middle Eocene of Hungary. In many respects both of these species are closely related to *Armatobalanus* and *Hesperibalanus,* subgenera of the genus *Balanus.* Strongly, moderately, or slightly ribbed forms appear in both of these groups, but the ribbing is not reflected internally as in *Kathpalmeria.* All of the presently known hesperibalanids possess well-developed radii which bridge completely the gap between the parietes; with one exception the same feature appears in all of the armatobalanids. In Recent hesperibalanids there is a well to poorly developed adductor ridge; fossil forms also show various degrees of development of this structure. On the other hand, certain of the armatobalanids, namely, *B. nefrens* and *quadrivittatus,* do not have an adductor ridge. The solid nature of the shell and basis, unusual folded walls, obsolete or diminutive radii, and the scutum with no adductor ridge should serve to distinguish this new genus from all of the presently known genera of the subfamily Balaninae.

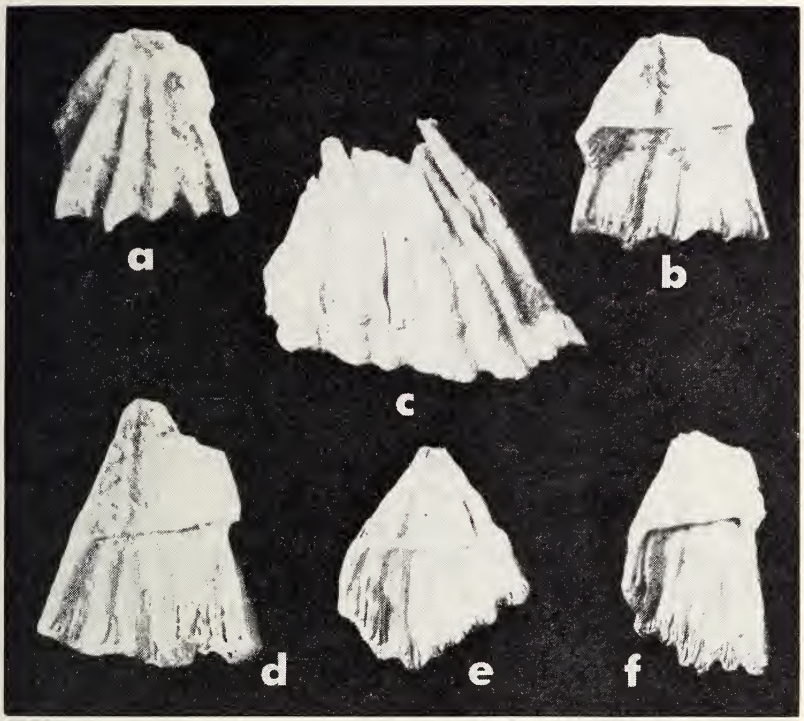

Fig. 2. *Kathpalmeria georgiana,* new genus, new species. *a, b,* external and internal views of right lateral, paratype, P.R.I. no. 6076, actual height 10 mm. *c,* external view of partially disarticulated shell, paratype, F.S.M. no. 4000, actual height 10.1 mm. *d,* internal view of right lateral, paratype, P.R.I. no. 6077, actual height 14.3 mm. *e,* internal view of rostrum, paratype, P.R.I. no. 6078, actual height 10.5 mm. *f,* internal view of right lateral, paratype, P.R.I. no. 6079, actual height 13.3 mm.

Kathpalmeria georgiana, new species

Description. The shell is low conic and of a moderate size. The mean height of six articulated specimens is 7.6 mm. The walls are moderate to strongly folded, the reentrants forming buttresses on the inner surface. Growth ridges on the external surface appear best developed on the reentrants. Viewed from the basal edge the parietal plates appear sinuous. The peritreme is but slightly toothed. The orifice is pentagonal in shape, being widest at the rostral end. The exterior of the parietes are ornamented with strong, moderately narrow to broad, non-digitating ribs; the

ribs extend from the base to the apex. The ribs are separated by approximately their own width or greater. On some plates there are intercalated secondary ribs. Under magnification alternating dark and light vertical bands of shell material can be seen. Upon weathering of the shell there is evidently a differential degree of solubility of these bands since the light bands are eroded, and the dark ones present the appearance of uniform secondary riblets. The radii are extremely narrow to obsolete, do not extend the complete height of the valve, and the sutural edges are septate. The septa appear as simple, square pegs; there are no denticles on either the top or bottom edges of the septa. The alae have horizontal summits, and the sutural edges of the alae are also septate. Internally, the inner shell surface is marked by subsidiary ribs on the inner manifestations of the ribs and reentrants. The ribs may extend to the hollow behind the sheath. The sheath surface is strongly scored, and the growth ridges are apically directed. The basal margin of the sheath is either free or attached. Where free, the hollow behind it is narrow, and moderately deep.

The surface of the flat basis is smooth. At the periphery denticles are developed which interlock with those developed on the basal edges of the wall plates. The wall plates and basis are apparently strongly articulated since most of the disarticulated compartments still retain peripheral portions of the basis.

The scutum is broadly triangular, and strongly concave between the basal margin and apex. The basal margin is slightly longer than the tergal margin. The occludent margin is not pectinate. The apex of the valve is broadly rounded. It cannot be determined at this time whether this is due to secondary erosion. A somewhat prominent sulcus extends from just left of the center of the apex and extends down the occludent side to the basal margin dividing the valve unequally. The exterior ornamentation consists of strong, spaced, growth ridges. It appears that the growth ridges may have been crossed by numerous, close-spaced longitudinal striae. The articular ridge is high, slightly reflexed, evenly arched, approximately two-thirds the length of the tergal margin, and distally terminates abruptly. The articular furrow is extremely broad, and moderately deep. There is no adductor ridge. The adductor muscle pit is large, somewhat above center, deep, and well defined apically, but open below. The inner face of the articular ridge, and possibly the apical portion of the valve proper, bear

prominent, rectilinear, parallel ridges. The pit for the lateral depressor muscle is neatly triangular, extremely deep, and extends apically about one-fourth the height of the valve. The mediad limits of the rostral depressor muscle pit are poorly defined, but the pit is deep and extends a short distance above the basal margin.

Disposition of Types. The holotype right scutum (fig. 1) and associated shell (not figured) are deposited in the collections of the Paleontological Research Institution, catalog numbers 6075b and 6075a, respectively. The paratypic material, with one exception as noted below, is deposited with the above institution, catalog numbers 6076 (right lateral, fig. 2a, b), 6077 (right lateral, fig. 2d), 6078 (rostrum, fig. 2e), 6079 (right lateral, fig. 2f), and 6080 (not figured). One partially disarticulated specimen (fig. 2c) has been placed in the Florida State Museum collections, catalogue number 4000.

Measurements of Holotype. Height of shell 8.1; carinorostral diameter of shell 11.5; carinorostral diameter of orifice 5.1; height of right scutum 4.3 mm.

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Literature Cited

Conrad, Timothy A. 1846a. Observations on the Eocene formation of the United States, with descriptions of species of shells, &c. occurring in it. Amer. Jour. Sci. Arts, ser. 2, vol. 1 (for 1845), no. 2, pp. 209-221.

———. 1846b. Descriptions of new species of organic remains from the upper Eocene limestone of Tampa Bay. *Ibid.*, ser. 2, vol. 2, no. 6, pp. 399-400.